OK to enter substitute spec. D.V. 9/16/03

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an automobile on-board and/or portable telephone system in which the number of channels can be increased easily.

2. Description of the Related Art

In recent years, automobile on-board and/or potable telephone systems of the code division multiple access (CDMA) type have been developed for practical use as described in a paper "On the System Design Aspects of Code Division Multiple Access (CDMA) Applied to Digital Cellular and Personal Communications Networks", May 19-22, 1991, IEEE Vehicular Technology Conference. A conventional example of the construction of the automobile on-board and/or portable telephone system the of CDMA is shown in FIG. 3. In the Figure, reference numeral 1 designates units at the transmitter side such as a base station and 2 units at the receiver side such as an automobile on-board telephone or a portable telephone. Denoted by reference numerals 3, 4 and 5 are information input lines which are provided, in the units at the transmitter side 1, in correspondence to channel numbers assigned to individual users and to which information from the individual users is inputted, the information input lines 3, 4 and 5 corresponding to channel numbers #1, #2 and #3, respectively. Reference numerals 6, 7 and 8 designate spread modulators connected to the information input lines 3, 4 and 5, respectively, and operative to perform spread processings in accordance with spread [code] codes corresponding to the individual channel numbers, and reference numeral 9 designates a combiner for synthesis and transmission of spread signals of a plurality of users. Denoted by reference numeral 10 is [an] a despreader adapted to perform in the units at the receiver side 2, a despread processing in accordance with a spread code of a channel assigned to each user. In the units at the transmitter side 1, the spread modulators 6, 7 and 8 are supplied with parameters W1(t), W2(t) and Wm(t) representative of orthogonal spread codes, respectively, and a parameter PN(t) representative of a pseudo-random noise series, and the orthogonal spread codes are multiplied by the pseudo-random noise series to produce spread codes corresponding to the individual channels and spread processings are carried out in accordance with the spread codes. In the following description, the pseudo-random noise series is referred to as the "PN" series. In the units at the receiver side 2, each equipment has [an] a despreader 10 and when the channel number of the units at the receiver side 2 shown in FIG. 3 is #i, that despreader 10 is supplied with a parameter Wi(t) representative of an orthogonal spread code and the parameter PN(t) representative of the PN series to perform a despread processing in accordance with a spread code corresponding to that channel. To perform the spread and despread processings as above, spread codes as exemplified in FIG. 4 are used inside a certain cell in correspondence to channel numbers assigned to individual users.

In the automobile on-board and/or portable telephone system constructed as above, when user information is inputted from each information input line 3, 4 or 5 at a predetermined information transmission bit rate, for example, B(bps), a spread processing is carried out, in the units at the transmitter side 1, by the spread modulator 6, 7 or 8 in accordance with a spread code corresponding to a channel number assigned to a user of interest and then spread signals of a plurality of users are combined in the combiner 9 and transmitted. On the other hand, when a combined spread signal is received in the units at the receiver side 2, the combined spread signal is subjected to a despread processing by the despreader 10 in accordance with a spread code of a channel number assigned to each user to reproduce the information at the information transmission bit rate B(bps) and the reproduced information is delivered out through an information output line 11.

Waveforms are changed as shown in FIGS. 5 to 7 when a signal representative of user information received at a certain information transmission bit rate is subjected to a spread processing, transmitted and then subjected to despread. The user information inputted from the information input line 3, 4 or 5 has the form of a spectrum signal 12 having a bandwidth of B and a power spectrum density of P. When this spectrum signal 12 undergoes a spread processing in the spread modulator 6, 7 or 8, power in the bandwidth B is spread to a spread bandwidth S of a spread multiplexed spectrum on a link path as shown in FIG. 6 to provide a spread signal 13 shown therein. Since the spread modulators 6, 7 and 8 correspond to channel numbers assigned to the individual users and the spread codes are set to different values in correspondence to the respective channel numbers as shown in FIG. 4, the spread signal 13 differs from channel to channel to assume a multiplexed structure. FIG. 6 shows an example of a 4-channel spread multiplexed spectrum.

When the spread signal 13 as above is subjected to a despread processing in the units at the receiver side 2, the despread processing is carried out in the units at the receiver side 2 under the condition that the orthogonal spread code is Wi(t) and the PN series is PN(t) and consequently, of the 4-channel spread multiple spectrum, a spread signal of a channel corresponding to this spread code, that is, the power of a desired wave, is again concentrated in the bandwidth B and multiplexed signals of the other users (for three channels) remain spread waveforms which exist as interference waves. Then when the multiplexed spectrum is filtered to pass the band B in the units at the receiver side 2, there [result] results a desired wave 14 subject to the despread and a spectrum of interference wave 15. As long as the ratio between power of the desired wave 14 and power of the interference wave 15, that is, the signal to interference ratio (SIR) can be maintained at a predetermined value, the necessary quality of communication can be maintained.

Also, when B=9600, that is, the information transmission bit rate is 9600 bps, a maximum of 64 channels can be set within a range in which the SIR can be maintained at a predetermined value from the viewpoint of coping with the interference and there is available an example of an automobile on-board and/or portable telephone system using 64 kinds of Walsh codes representative of orthogonal spread [code] codes.

In the aforementioned conventional automobile on-board and/or portable telephone system, however, the maximum [channel] number of channels of the outbound link path (a link path [bound] from the base station to an automobile on-board telephone or a portable telephone) in one cell is limited to the number of orthogonal spread codes ([assuming] assumed to be m) and, for example, even [when a] if voice signal [coded] coding (coding/decoding unit) having a rate which is half the presently existing rate becomes applicable in the future in the field of communication, there will be a disadvantage in that the subscriber capacity [of subscribers] cannot be increased because of a shortage of [the number of assigned] codes or series in spite of the fact that link paths in excess of m channels [are] could be set up in one cell from the viewpoint of the necessary SIR and the requisite quality [can] could be maintained for performing communication.